ESTIMATING VENTRICULAR STROKE WORK FROM AORTIC PRESSURE WAVEFORM

S.Kamoi[1], C.G.Pretty[1], Y.S.Chiew[1], A.Pironet[2], T.Desaive[2], G.M.Shaw[3], J.G.Chase[1]

[1]Department of Mechanical Engineering, University of Canterbury, New Zealand

[2]GIGA Cardiovascular Science, University of Liege, Belgium

[3]Intensive Care Unit, Christchurch Hospital, New Zealand

1. Introduction

Ventricular Stroke Work (VSW) is an important physiological parameter when assessing patient cardiovascular performance. Decreased VSW occurs during many states of cardiovascular dysfunction. However, quantifying VSW normally requires ventricular pressure and volume measurements, which are highly invasive and thus typically unavailable clinically. This research presents a model-based analysis of aortic pressure contours to estimate beat-to-beat VSW trends through the aortic pressure-velocity gradient (*ρc*).

2. Methods

Figure 1 illustrates the method used for identifying *ρc* from measured data for each beat.

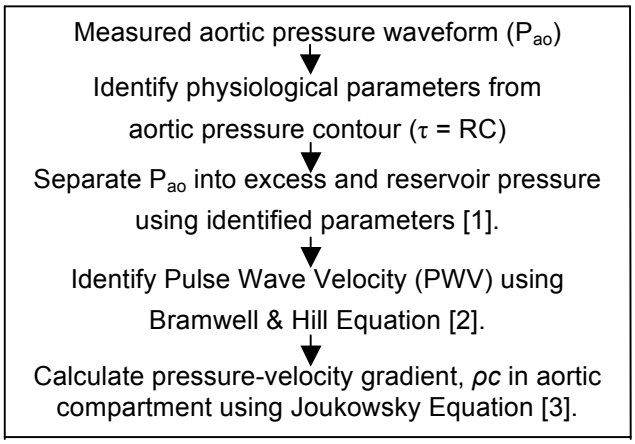

Figure 1 - Schematic of estimation procedure

Data from porcine experiments were used to validate the accuracy of *ρc* to estimate VSW using measured ventricular pressures and volumes.

3. Results and Discussion

The correlation coefficient between measured VSW calculated from a Pressure-Volume loop and model-based estimate of *ρc* from aortic pressure showed good agreement with R = 0.71.

Figure 2 shows a time-series of measured VSW and estimated *ρc* during hemodynamic changes induced via alterations to mechanical ventilation pressure during an experiment (stepwise PEEP recruitment maneuver).Clearly, *ρc* captures trends in VSW very well.

The methods presented in this study show the potential for continuous, accurate monitoring of VSW trends by estimating pressure-velocity relationship in the aortic compartment. Importantly, this method only requires an aortic pressure measurement, which is often available in intensive care patients.

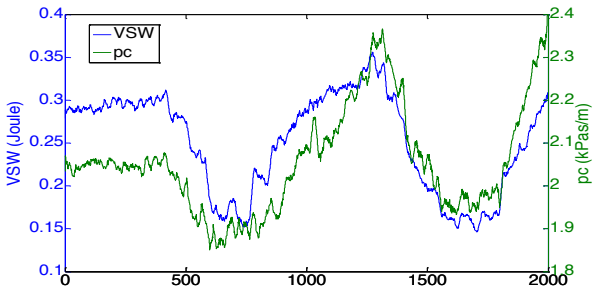

Figure 2 – Time-series plot of measured VSW and estimated *ρc* from model based analysis of aortic pressure contour

References

[1] S. Kamoi, et al., "Continuous stroke volume estimation from aortic pressure using zero dimensional aortic model," PLOS ONE, 9(7), 2014.

[2] J. C. Bramwell, et al., "The velocity of the pulse wave in man," Proceedings of the Royal Society of London. Series B, 93(652), 1922.

[3] A. S. Tijsseling et al., "The Joukowsky equation for fluids and solids," Proceedings of the 9th Intl. Conf. on Pressure Surges, 2004.

Keyword(s): biomechanics - biosignals